Design and Control of a Running Biped with Pneumatic Artificial Muscles

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INTRODUCTION

We humans utilize body compliance provided by antagonistic muscles to realize dynamic locomotion such as running and jumping. In this paper, we introduce design of a biped driven by antagonistic pairs of artificial pneumatic muscles so that the robot can change compliance according to the desired locomotion. We propose simple controllers for realizing such dynamic motions. We report several experimental results on its walking, jumping, and running.

DESIGN OF A WALKING/RUNNING BIPED

We have designed a biped "Que-Kaku-R" driven by antagonistic pairs of pneumatic actuators (Figure 1). Its height, width and weight are 0.9[m], 0.26[m], and 6.0[kg], respectively. It has 5 degrees of freedom: 1 hip, 2 knees and 2 ankles so that it can jump and run. Every joint is driven by a pair of antagonistic pneumatic muscles. The supplied air pressure is 0.6 [MPa]. It has two touch sensors on its feet to sense the impact.

WALKING, JUMPING, AND RUNNING EXPERIMENTS

We basically adopt a walking controller utilizing passive dynamics [1]. A sequence of valve operation is pre-programmed, and it is initiated by the touch sensation of the feet. Control parameters such as duration of opening a valve is determined by trial and error. A walking sequence is shown in Figure 2.

For jumping and running, we adopt the same strategy with different control parameters. Figure 2 and 3 show sequences of jumping and running, respectively. It can realize fully dynamic motions by effectively utilizing its dynamics and compliance of the pneumatic actuators.

REFERENCES

1. Takuma, T., Hosoda, K., Ogino, M., and Asada M., "Stabilization of Quasi-Passive Pneumatic Muscle Walker". IEEE-RAS/RSJ Int. Conf. on Humanoid Robots (Humanoids 2004), Vol.CD-ROM, 2004.
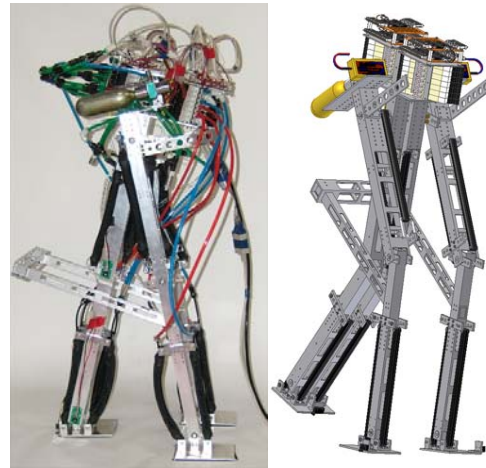
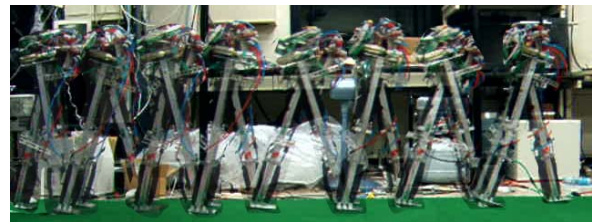**Figure 1**: A Biped robot "Que-Kaku-R" that can walk and run.
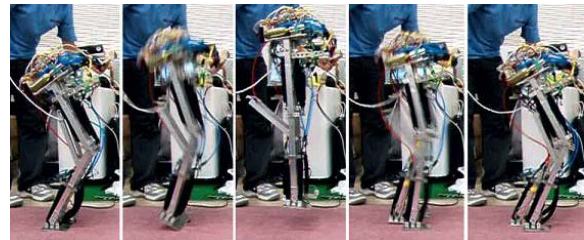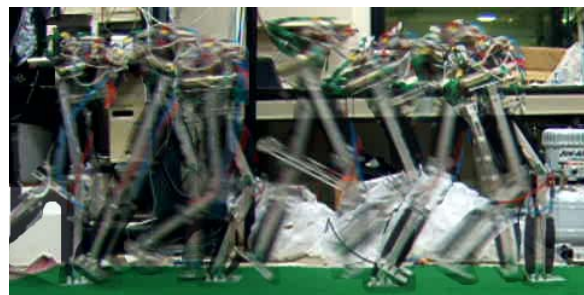

Figure 2: A walking sequence

Figure 3: A jumping sequence

Figure 4: A running sequence